
A New Species of *Gaultheria* (Ericaceae) from Mount Kinabalu, Borneo, Malaysia

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ABSTRACT. We describe *Gaultheria paucinervia* P. W. Fritsch & C. M. Bush (Ericaceae: Gaultherieae), a new species apparently restricted to the eastern slopes of Mt. Kinabalu in Sabah State, Borneo, Malaysia. This species has been confused with *G. borneensis* Stapf, but differs in its more erect habit and larger stature, longer nonappressed leaf trichomes, purple (vs. white) fruiting calyx, and lower elevation range, among other features. The two species are furthermore well separated in molecular phylogenetic analyses, with *G. paucinervia* grouping in a clade of other eastern Asian species sharing whitish green abaxial leaf surfaces, racemose inflorescences, and a fleshy calyx surrounding a dry capsule.

Key words: Borneo, Ericaceae, *Gaultheria*, IUCN Red List, Kinabalu National Park, Malaysia, Mt. Kinabalu.

Gaultheria borneensis Stapf (Ericaceae) is known from Malaysia (Mt. Kinabalu, Borneo), the Philippines (Luzon), and Taiwan, ranging in elevation from 1600 to 4000 m (Sleumer, 1967; Fang & Stevens, 2005). During fieldwork on Mt. Kinabalu in Kinabalu National Park of Sabah State, Borneo, Malaysia, in July of 2009, we collected what has been anecdotally considered a lower-elevation element of *G. borneensis* restricted to Mt. Kinabalu (Sleumer, 1967). The plants comprising this element, occurring between 2440 and 2750 m elevation, were distinguished from those of *G. borneensis* occurring at higher elevations on Mt. Kinabalu (3350–4000 m) by their larger and more erect habit, larger leaves, one to five racemes from the upper leaf axils (vs. only one), and a purple (vs. white) fruiting calyx (Sleumer, 1967). We have been able to examine herbarium material annotated as *G. borneensis* from CAS and on loan to the first author from BM, E, and K, comprising 51 specimens collected from throughout the known geographic range of the species. This material included the

holotype of *G. borneensis* (Stapf, 1894: 190, t. 15C, 4–6, Malaysia. Sabah: Mt. Kinabalu, 12,000 ft., *G. D. Haviland 1085* [holotype, K]) and five collections of the lower-elevation Mt. Kinabalu element; the latter includes one specimen annotated by H. O. Sleumer in 1962 as the “special form at lower altitudes” (*P. Collette 633*, K). Based on the many morphological differences between the lower-elevation Mt. Kinabalu element and the other specimens of *G. borneensis* from throughout the range of the species, as well as a DNA-based phylogenetic study of *Gaultheria* Kalm ex L. in which samples of the lower-elevation Mt. Kinabalu plants and a sample of *G. borneensis* from the Philippines (*S. P. vander Kloet 2101092*, ACAD) are recovered in distinct clades (Fritsch et al., 2011), we describe this element as a new species.

Gaultheria paucinervia P. W. Fritsch & C. M. Bush, sp. nov. TYPE: Malaysia. Sabah [Borneo]: Ranau Distr., Kinabalu Natl. Park, along Mesilau Trail, 6.04062°, 111.56639°, 2488 m, 6 July 2009, P. W. Fritsch, C. M. Bush, Y. Johalin & M. R. B. Salleh 1860 (holotype, SNP; isotypes, CAS, WFU). Figures 1, 2.

Haec species a *Gaultheria borneensi* Stapf habitu erecto 0.3–2.4 m alto, lamina foliari 1.8–2.4 × 0.6–1 cm, trichomatibus ramuli laminaeque adpressis vel ascendentibus eglandulosis usque ad 0.7 mm longis, racemis 1 vel 2 (ad 5) in quoque ramulo, pedicellis erectis, bracteolis carinatis margine glanduloso-serratis, lobis calycis 2–2.5 × 1.7–2 mm intra dense hirtellis atque calyce sub fructu purpureo differt.

Shrubs 0.3–2.4 m tall, terrestrial, erect, evergreen, many-branched; young branchlets brown (green or strongly flushed with red when fresh), smooth, white-puberulent and with scattered ascending-uncinate black setae. Petiole 0–3.5 mm, red when fresh; leaf blades elliptic to slightly oblanceolate, 1.8–2.4 × 0.6–1 cm, smaller distally along branches and sometimes grading into inflorescence bracts, 2.4–

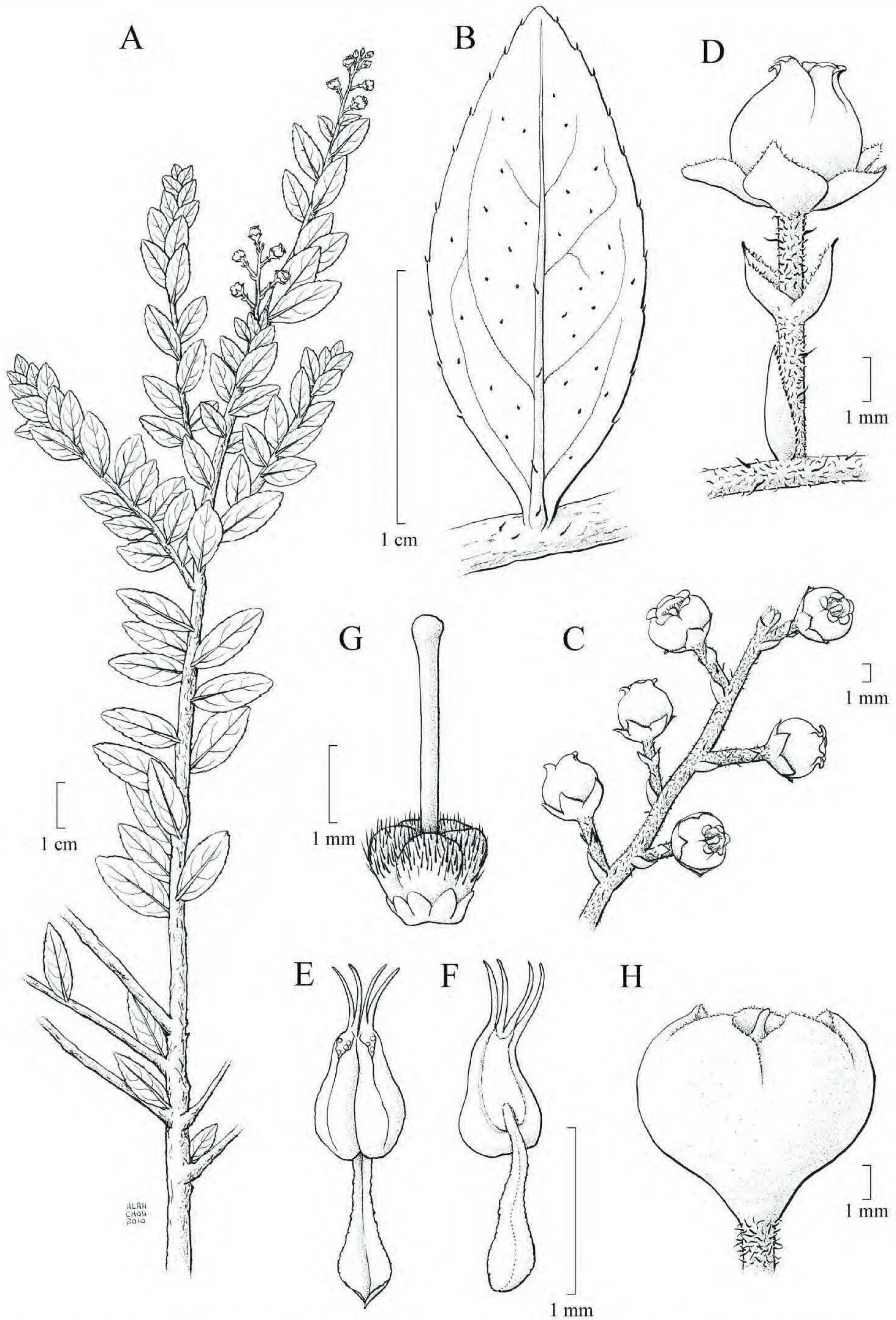


Figure 1. *Gaultheria paucinervia* P. W. Fritsch & C. M. Bush. —A. Flowering branch. —B. Branchlet segment and leaf. —C. Inflorescence. —D. Rachis segment, pedicel, and flower. —E. Stamen, ventral view. —F. Stamen, dorsal view showing central region of disintegration tissue. —G. Gynoecium and basal nectary glands. —H. Fruit. A, B drawn from the isotype P. W. Fritsch et al. 1860 (CAS); C–G from *G. Argent* 1643 (E); H from W. L. Chew & E. J. H. Corner 7146 (K).

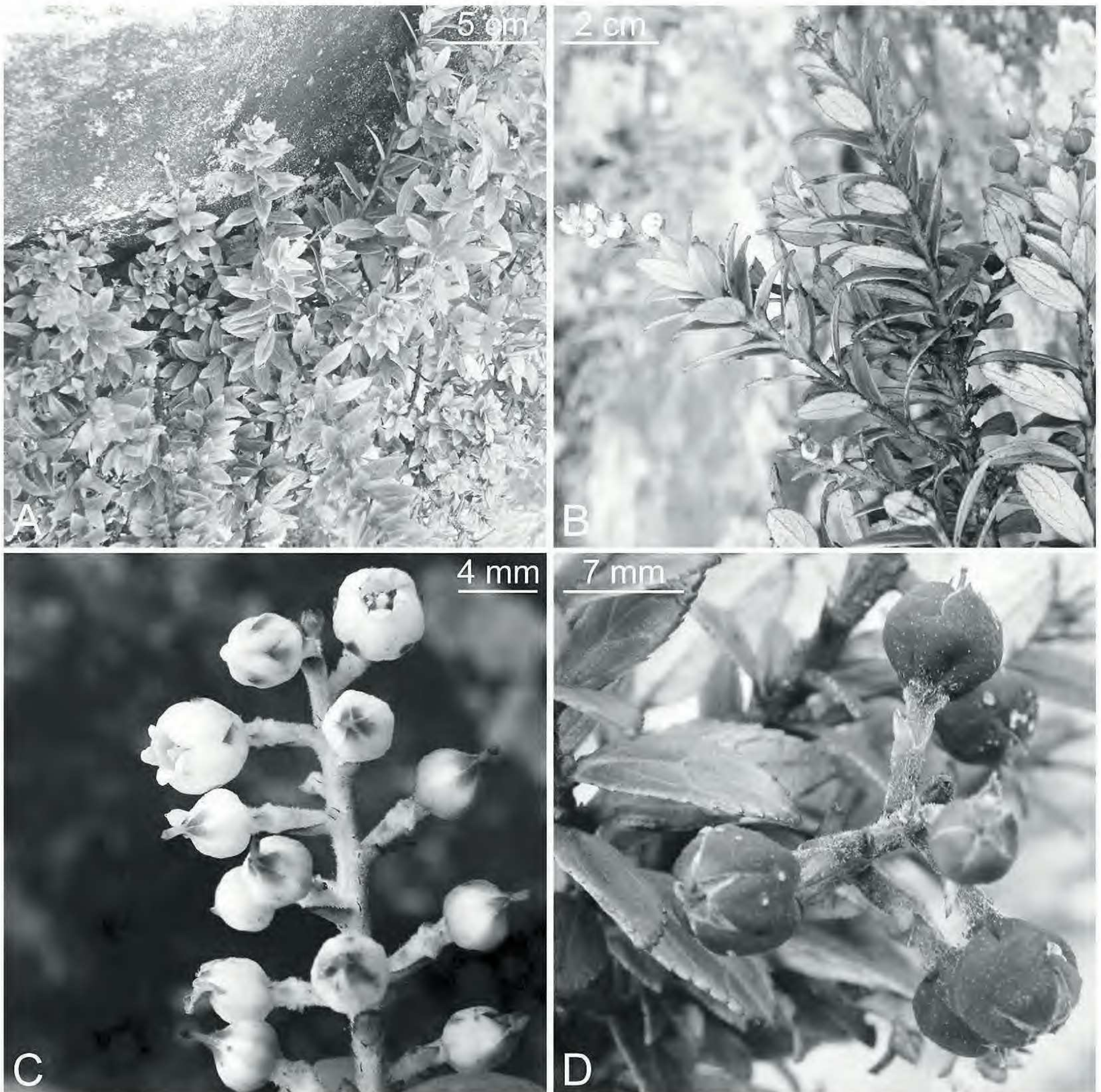


Figure 2. *Gaultheria paucinervia* P. W. Fritsch & C. M. Bush. —A. Habit. —B. Branchlets with flower buds and young fruit. —C. Inflorescence. —D. Fruit. A–D from the isotype P. W. Fritsch *et al.* 1860 (CAS). Photographs by P.W.F.

4.2× as long as wide, subcoriaceous, with strong wintergreen odor when crushed, abaxially greenish white or light to dark brown (greenish white except for red base along midvein when fresh), red to black punctate, the punctae often bearing antrorsely appressed or ascending nonglandular-tipped setae of various lengths to 0.7 mm, adaxially dull green, basally white-puberulent and also with scattered dark glandular hairs especially along midvein, midvein abaxially raised, adaxially slightly so, secondary veins arcuate, 2(3) on each side of midvein, only the distalmost pair reaching leaf apex, abaxially raised, adaxially slightly impressed, planar, or obscure, tertiary veins abaxially raised, adaxially obscure, base cuneate, margin flushed with red when

fresh, revolute, serrulate throughout with 10 to 14 teeth per side, marginal setae to ca. 0.3 mm, apex retusely glandular-acute. Inflorescences terminal, racemose, 1 or 2(to 5) per branchlet, when multiple then together appearing paniculate and branched near base, 2–4 cm long, 9- to 15-flowered; rachis densely white-villulose and sometimes sparsely setulose; bracts oblong-lanceolate, linear-lanceolate, or ± spatulate, not keeled, 4–5.5 × 1–1.2 mm, smaller distally, persistent, abaxially glabrous or puberulent, sometimes also setulose, adaxially puberulent, glandular-serrate and sometimes white-ciliate, apex glandular-acute; pedicels 4–5 mm (somewhat longer in fruit), erect, white-villulose; bracteoles borne on middle of pedicel, ovate-deltoid,

keeled, $1.5\text{--}2 \times 1.2\text{--}1.5$ mm, otherwise similar to bracts. Calyx 3–4 mm; lobes 5, white tipped with dark pink, ovate, $2\text{--}2.5 \times 1.7\text{--}2$ mm, outside glabrous, inside densely hirtellous, not keeled, margin ciliate, apex acuminate-aristate; corolla white, globose-urceolate, $4\text{--}4.5 \times 3\text{--}3.5$ mm, glabrous outside and inside; lobes 5, oblong or oblong-deltoid, $0.7\text{--}1.5$ mm; stamens 10; filaments $1.2\text{--}1.4$ mm, slightly dilated proximally, papillose especially along margins, otherwise glabrous; anthers 1–1.2 mm, with white disintegration tissue dorsally, awns 2 per theca, $0.5\text{--}0.6$ mm; ovary densely white-hirtellous; style $1.5\text{--}2.5$ mm, glabrous. Fruiting calyx red when immature, purple at maturity, fleshy; lobes erect to reflexed when dry, not pale-edged; capsule 5–7 mm diam.; seeds oblique-pyramidal, shallowly areolate, ca. 0.8 mm.

Distribution and habitat. *Gaultheria paucinervia* is known only from the eastern slopes of Mt. Kinabalu from ca. 2350 to 2750 m elevation, occurring in the primary upper montane rainforest zone, where it grows on granitic ridges in open shrubby areas on clay.

IUCN Red List category. *Gaultheria paucinervia* has apparently been collected only in a protected area of Kinabalu National Park along the Mesilau Trail, which traverses part of the eastern escarpment of Mt. Kinabalu. Assuming the species is endemic to the eastern slopes and shoulder of Mt. Kinabalu within the elevational ranges recorded for the species, we estimate the area of occupancy as ≤ 20 km². At the type locality along the Mesilau Trail, we could only find several plants clustered at the base of a large rock in a forest opening. Based on IUCN Red List criteria (IUCN, 2001), we assign a preliminary status of Vulnerable (VU D2).

Phenology. *Gaultheria paucinervia* has been collected in flower in March, April, July, and December, and in fruit in March and July.

Etymology. The specific epithet of this new species is taken from the Latin and refers to the small number of secondary veins on the leaf blades relative to most other species of *Gaultheria*.

Discussion. Airy Shaw (1941) considered *Gaultheria borneensis*, *G. cuneata* (Rehder & E. H. Wilson) Bean, *G. prostrata* W. W. Sm., *G. pyroloides* Miq., and *G. pyrolifolia* Hook. f. ex C. B. Clarke to be close relatives based on a shared \pm sympodial relation of the inflorescence to the main vegetative axis. These species are all diminutive prostrate shrubs with small leaves and a white fruiting calyx except for *G. pyrolifolia*, in which the fruiting calyx is

purple (Fritsch & Trock, 2007; Fritsch et al., 2008). The white-fruited species of this group all form a strongly supported Sympodial clade in molecular phylogenetic studies, whereas *G. pyrolifolia* groups within a large *Gaultheria* ser. *Leucothoides* [(Airy Shaw) D. J. Middleton] s.l. clade, as does a sample of our new species (Lu et al., 2010; Fritsch et al., 2011). It is unclear to us precisely what Airy Shaw intended by his use of sympodial in describing the relationships of these species, but this term may allude to the several prominent perulae alternately arranged toward the base of the inflorescence axis in the species of the Sympodial clade. *Gaultheria paucinervia* lacks these perulae, instead bearing leaves that undergo a gradual or abrupt transition to bracts distally along the length of the continuous branchlet and inflorescence axis.

We confirm the utility of characters used by Sleumer (1967) to delimit *Gaultheria borneensis* s. str. from his special form here called *G. paucinervia*, i.e., a prostrate shrub habit to 0.6 m tall (vs. an erect shrub to 2.4 m), leaf blades $0.8\text{--}1.5\text{--}2 \times 0.3\text{--}0.7$ cm (vs. $1.8\text{--}2.4 \times 0.6\text{--}1$ cm), only one raceme per branchlet (vs. one to five), and a white fruiting calyx (vs. purple). In addition to the lack of inflorescence perulae, *G. paucinervia* is further distinguished from *G. borneensis* by the following characters: appressed, glandular-tipped branchlet and leaf trichomes to 0.3 mm long (vs. appressed to ascending, nonglandular-tipped, and to 0.7 mm long); lustrous leaf surfaces adaxially (vs. dull); pedicels recurved (vs. erect); bracteoles not keeled and with the margins not or only weakly glandular (vs. keeled and with the margins glandular-serrate); and calyx lobes $1\text{--}1.8 \times 0.7\text{--}1.5$ mm, strigillose or puberulent inside (vs. $2\text{--}2.5 \times 1.7\text{--}2$ mm, densely hirtellous inside).

On Mt. Kinabalu, *Gaultheria borneensis* occupies the acid thin organic soils of subalpine woodland or scrub under almost constant diurnal fog and humidity, whereas *G. paucinervia* occurs in upper montane rainforest where periodic droughts can occur and soils are deeper and have more clay content. Correlated with these habitat features, many woody species of the subalpine zone are lower in stature and have leaves that are adaxially smaller (often nanophyllous), concave, and more lustrous than relatives in the upper montane zone (Stapf, 1894; Kitayama, 1991; P. Ashton, pers. comm.). The two species of *Gaultheria* parallel the trends between habitat and morphology in these respects.

Gaultheria malayana Airy Shaw of Peninsular Malaysia and *G. paucinervia* form the sister group of a clade comprising *G. discolor* Nutt. ex Hook. f. and *G. straminea* R. C. Fang in phylogenetic studies (Lu et

al., 2010; Fritsch et al., 2011). These four species share leaf blades that are abaxially greenish white when fresh, a relatively uncommon feature in the larger *Gaultheria* ser. *Leucothoides* s.l. clade to which they belong. *Gaultheria malayana* is distinguishable from *G. paucinervia* by a longer petiole 5–10 mm (vs. 0–3.5 mm), leaf blades $3.5\text{--}6.5 \times 1.5\text{--}4.7$ cm (vs. $1.8\text{--}2.4 \times 0.6\text{--}1$ cm) with five (to seven) secondary veins on each side of the midvein (vs. two [or three]), and bracteoles borne on the apex of the pedicel (vs. on the middle).

The only Malesian species of *Gaultheria* with racemose inflorescences and bracteoles borne on the middle of the pedicel other than *G. borneensis* are *G. acroleia* Sleumer, *G. barbulate* Sleumer, *G. atjehensis* J. J. Sm., *G. dialypetala* Sleumer, and *G. solitaria* Sleumer (Sleumer, 1967). The first two species are distinguished from *G. paucinervia* by larger leaf blades at least 3×2 cm (vs. $1.8\text{--}2.4 \times 0.6\text{--}1$ cm), and the latter three by ovate leaf blades (vs. elliptic to slightly oblanceolate; Sleumer, 1967). *Gaultheria dialypetala* from Sumatra has yet to be sampled for molecular phylogenetic data and may be the closest relative of *G. paucinervia*, the two sharing a similarly short petiole (1–2 mm), small leaf blades ($1\text{--}2 \times 0.8\text{--}1.3$ cm) with few secondary veins (usually three on each side of the midvein), glabrous corollas, merely papillose stamen filaments, and a densely pubescent ovary. In addition to its ovate leaf blades, the taxon differs from *G. paucinervia* by its prostrate habit 0.3–0.4 cm tall (vs. erect and 0.3–2.4 m), 1- to 5-flowered racemes (vs. 9- to 15-flowered), and a pubescent style (vs. glabrous).

Paratypes. MALAYSIA. **Sabah:** above Mesilau East River, ca. $6^{\circ}03'N$, $116^{\circ}33'E$, 2500 m, 4 Apr. 1980 (fl.), *G. Argent 1643* (E); Mentaki Ridge, 7800 ft., 17 Mar. 1964 (fl., fr.), *W. L. Chew & E. J. H. Corner 7146* (K); new rte. up Mt. Kinabalu (SE face), 9000 ft., 16 Dec. 1960 (fl.), *P. Collette 633* (K); Mesilau rte., 8000 ft., 24 July 1963 (fl., fr.), *W. Meijer s.n.* (K).

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